Assessment of Vulnerability to Natural Hazards

A European Perspective



Edited by

Jörn Birkmann, Stefan Kienberger
and David E. Alexander

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Chapter 1

Theoretical and Conceptual Framework for the Assessment of Vulnerability to Natural Hazards and Climate Change in Europe[1]

The MOVE Framework

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Chapter Outline

1. This chapter is based on a paper published in Natural Hazards dealing with the MOVE framework; see in detail Birkmann et al., 2013.

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1.1 INTRODUCTION

Newest global assessment reports (GAR, 2011; Welle et al., 2012; IPCC, 2013; IPCC, 2014) underscore that risk reduction and resilience building remains a key challenge for developing and developed countries alike particularly due to the increasing exposure of people and assets in high risk zones and the intensification of extreme events in the context of climate change (see e.g., IPCC, 2013). It is increasingly recognized that natural hazard associated risk and threats to human security cannot be reduced by focusing solely on the hazards. Societies will have to live with changing environmental conditions and therefore need to build resilience by reducing vulnerabilities to natural hazards. Vulnerability assessment of natural hazards and climate change has emerged in the past decades as an important research field (see e.g., Maskrey, 1984; Chambers, 1989; Pelling, 1997; Cardona, 2001; Birkmann, 2006a,b; Adger, 2006; IPCC, 2007; Bohle, 2008; Bohle and Glade, 2008; Oxfam America, 2009; Birkmann, 2013) bringing together scientists from different disciplines (Fuchs, 2009). The following chapter outlines a framework for multidimensional, holistic vulnerability assessment that is understood as part of risk evaluation and risk management in the context of Disaster Risk Management (DRM)[2] and Climate Change Adaptation (CCA). As a heuristic, the framework is a thinking tool to guide systematic assessments of vulnerability and to provide a basis for comparative indicators and criteria development to assess key factors and various dimensions of vulnerability, particularly in regions in Europe, however, it can also be applied in other world regions. The framework has been developed within the context of the research project MOVE (Methods for the Improvement of Vulnerability Assessment in Europe; www.move-fp7.eu) sponsored by the European Commission within the framework of the FP 7 program.

2. The term Disaster Risk Management (DRM) also encompasses the concept of Disaster Risk Reduction (DRR). Thus these terms are used almost synonymously.

1.2 RISK, VULNERABILITY, AND ADAPTATION TO NATURAL HAZARDS

1.2.1 Definitions and Perspectives

The concept of vulnerability is today a core concept that links important research communities, particularly DRM, CCA, and development research. However, definitions of vulnerability are contested and research on vulnerability is underpinned by multiple disciplinary theories based upon natural or social science epistemologies. This results in a range of paradigms for approaching vulnerability and is supported by qualitative and quantitative assessment methodologies (Pelling, 2001; Birkmann, 2006a,b; O'Brien et al., 2007; Birkmann, 2013; Fuchs, 2009).

The natural science research communities often focus on the quantification of different factors of vulnerability (e.g., Kienberger et al., 2009; O'Brien et al., 2007). The aim of these approaches—particularly regarding physical vulnerability—is to define and quantify damage ranges illustrated through vulnerability curves in order to help determine acceptable levels of potential losses (Papathoma-Köhle et al., 2011). Social science approaches often encompass a broad focus and examine, in particular, the likelihood that an individual household or a community will suffer harm or experience losses related to environmental hazards, as well as the context conditions that influence social vulnerability (DFID, 1999; Wisner et al., 2004). In this context, Phillips and Fordham (2009) emphasize that social vulnerability to natural hazards is driven by social inequality and is deeply embedded in social structures that are often resistant to change (Phillips and Fordham, 2009). Besides a clear differentiation of risk and vulnerability, the MOVE framework aims at integrating the concept of adaptation in vulnerability assessments to natural hazards. In this way, the MOVE framework seeks to enhance the DRR perspective by integrating new understanding of coupling, adaptation, and resilience. In this regard, the framework might also serve as a tool to link particularly the DRR and CCA community as well as the resilience research community.

Before discussing the different components of the framework and the key factors of vulnerability in more depth, it is essential to outline the basic understanding of disaster risk and vulnerability as well as adaptation applied within the context of the framework.

1.2.1.1 Social Construction of Risk

The concept of vulnerability underscores the social construction of risk and is supported empirically by a range of studies applying vulnerability to help understand risk to hazards, including those with a focus on climate change (Aysan, 1993; Blaikie et al., 1996; Wisner et al., 2004). Vulnerability refers to the propensity of exposed elements such as physical or capital assets, as well as human beings and their livelihoods, to experience harm and suffer damage and loss when impacted by single or compound hazard events (UNDRO, 1980; Timmerman, 1981; Maskrey, 1984; Cardona, 1986, 1990; Liverman, 1990; Cannon, 1994, 2006; Blaikie et al., 1996; UNISDR, 2004, 2009; Birkmann, 2006b,c; Cutter et al., 2003; Cutter and Finch, 2008; Cutter et al., 2008). While there

is broad agreement on the aspects of the social construction of risk (Chambers, 1989; Cannon, 1994; Lavell, 1999; Wisner, 2006; Carreño et al., 2007a,b; Cardona, 2004), it is at the level of measurement where the challenge remains. The difficulty lies in assessing the various dimensions of vulnerability and its multifaceted and dynamic nature (see e.g., Birkmann, 2006b,c; Birkmann, 2013).

1.2.1.2 Risk and Disasters

While risk and vulnerability can be seen as continuums, a disaster is but a moment or materialization of these underlying conditions. Dynamic changes of vulnerability and hazard phenomena also mean that risk is nonstatic; it changes over time and these changes have to be considered when applying specific assessments, as well as when developing corrective (current risk) or prospective (future risk) interventions. Overall, disasters are the product of a complex relationship between the physical environment, both the natural and built environment, and society; its behavior, function, organization, and development, including human perception (Quarantelli, 1998). The term disaster often refers to a social condition whereby the normal functioning of a social system has been severely interrupted by the levels of loss, damage, and impact suffered (Cardona, 1990; Alexander, 1993, 2000; Birkmann, 2006b). However, disaster can also function as a catalyst for change (see e.g., Birkmann et al., 2010). Pelling and Dill (2010) demonstrate how disasters and crises can also catalyze reorganization and learning processes in communities or societies, often accelerating underlying policy and social trajectories. The concept of resilience has developed in different schools of thought, such as ecology (e.g., Holling, 1973), psychology (e.g., Bonanno et al., 2006; Bonanno, 2008), social-ecological systems research (e.g., Berkes et al., 2003; Folke, 2006), and critical infrastructures (e.g., Boin and McConnell, 2007). In general, resilience research is concerned with the ability of a system or a person to deal with disturbances and the effect of stressors. In addition, resilience research, particularly with regard to social-ecological systems or infrastructures, focuses on capacities of systems to reorganize themselves in the face of adverse events through processes described as revolt and remember and respective innovation processes. Within the framework, we refer to resilience mainly in terms of the lack of resilience, hence the limited capacities to cope or to recover in the face of adverse consequences. At the same time we acknowledge that "improving resilience" is part of adaptation within our framework. Hence the resilience concept is attributed to two core components of the MOVE framework: coping and adaptation.

1.2.1.3 Adaptation and Coping

Adaptation in early reports of the IPCC has not received much attention, since the overall perception was that too much emphasis on adaptation would contradict strict goals for the reduction of green house gas emissions. However, today

adaptation is a core concept with the climate change context and goes far beyond a rather biological and reactive understanding of adjustment. Hence, adaptation presents itself as a continuous property, with levels of adaptive capacity changing over time as the status of vulnerability components identified above change and the demands of a shifting risk environment alter the appropriateness of particular asset bundles for risk reduction (Pelling, 2001). Such changes can be a result of disaster events but also everyday processes of development. It should be noted that adaptation is distinct from coping. Coping we see as an aspect of resilience that signifies the "here and now" capacity and includes a set of actions available to those at risk. Coping in this way is part of the formula that determines vulnerability at any one moment in time. However, coping mainly deals with the conservation and protection of the current system and institutional settings (see Birkmann, 2010). Adaptation, by contrast, denotes a longer-term and constantly unfolding process of learning, experimentation, and change that feeds into vulnerability. Adaptation can be felt acting to shape all aspects of vulnerability and is observable through the systems and outcomes of learning—planned and spontaneous, pre and postdisaster (Pelling, 2010). This understanding of adaptation is commensurate with the emerging consensus from climate change (see Kelly and Adger, 2000; Yohe and Tol, 2002; Pelling, 2010) where coping is seen to describe actions taken within existing constraints (including vision and knowledge), and adaptation signifies change in the framing institutions.

1.2.2 Frameworks on How to Systematize Vulnerability in Different Communities

In recent years different frameworks have been developed to systematize risk, different facets of vulnerability and resilience (see overview in Birkmann, 2013). Thomalla et al. (2006) and Mitchell and van Aalst (2009) examine commonalities and differences between the CCA and DRM communities and identify key areas of convergence. They conclude that the two communities perceive the nature and timescale of the threat differently: if impacts due to climate change are surrounded by uncertainty, considerable knowledge and certainty exists about the event characteristics and exposures related to extreme environmental conditions based on historical experience. However, it has to be acknowledged that climate change challenges the historical knowledge of natural hazard events, particularly due to the modification of frequency and intensity of such events (Keiler et al., 2010).

CCA increasingly places emphasis on improving the capacity of governments and communities to address existing vulnerabilities to current climate variability and climatic extremes (Thomalla et al., 2006). Echoing the longstanding concerns of the disaster management community for a more socially informed approach to risk management (e.g., Hewitt, 1983; Burton et al., 1993) and from the climate change community, O'Brien et al. (2004) call for an integration of "underlying causes" of vulnerability and adaptive capacity in climate

change impact assessments rather than only focusing on adaptive capacity and technical measures. Furthermore, Birkmann and Teichman (2010) argue that the DRM and the CCA communities differ particularly in terms of the spatial, temporal, and functional scales applied within their research. Additionally, Romieu et al. (2010) examined different frameworks and assessment approaches used within CCA and DRM. They concluded that differences are particularly linked to process (stress versus shock), scale (temporal, functional, and spatial), assessment approach (statistical versus prospective), and levels of uncertainty.

1.2.2.1 Different Frameworks to Systematize and Define Vulnerability

The DRM and CCA communities share common roots in social and political science, however, four distinct approaches to understanding vulnerability and risk can be identified. The four approaches are not contradictory but rather approach risk from a specific viewpoint and with particular ends in mind—from the unearthing of systems linkages from the global to the local to the search for quantifiable risk measures. This section provides a brief overview of each approach to help illustrate the key differences and similarities behind these ways of conceptualizing and measuring risk and its components. Each approach has been considered in the production of the integrated framework proposed in this paper. The four approaches can be distinguished between those that are rooted in (1) political economy; (2) social-ecology; (3) vulnerability and disaster risk assessment from a holistic view; and (4) climate change systems science.

The political economy approach can be illustrated by the pressure and release (PAR) model published in Blaikie et al. (1994) and Wisner et al. (2004). This links vulnerability to unsafe conditions and discrete risk in a continuum of vulnerability that connects local risk to wider national and global shifts in the political economy of resources and political power. Associated with this approach and operating across development studies more generally is the Sustainable Livelihood Framework (see DFID, 1999). Applied in risk contexts most commonly to help understand household impacts and coping when faced with food insecurity, the framework successfully unpacks the range of assets that are at risk and can be used to generate security from disaster. Importantly from a political economy perspective, the framework directs attention to the ways in which the organizational, institutional, and political context helps to shape local capacity—but also recognizes that these structures are reproduced through the actions of individuals and households. The social-ecology perspective emphasizes the need to focus on coupled human-environmental systems when dealing with the assessment of risk. The best known visualization of this approach has been developed and published by Turner et al. (2003). Compared to political economy, the perspective of social ecology stresses the transformative qualities of society with regard to nature—and also the effects of changes in the environment on social and economic systems. It argues that the exposure and

susceptibility of a system can only be adequately understood if these coupling processes and interactions are addressed.

Comprehensive perspectives from vulnerability and disaster risk assessment have tried to develop an integrated explanation of risk. These approaches particularly differentiate exposure, susceptibility, and societal response capacities or the lack of resilience (see Cardona, 1999a,b, 2001, 2010; IDEA, 2005; Birkmann, 2006a; Carreño, 2006; Carreño et al., 2007a,b; Birkmann and Fernando, 2008; Barbat et al., 2011; Carreño et al., 2012). A core element of these approaches is a feedback-loop system which underlines that vulnerability is dynamic and that vulnerability assessment cannot be limited to the identification of deficiencies, but rather also take into account the potential feedback loops and intervention tools that exist or can be developed in order to reduce vulnerability. Moreover, the approaches of so called integrative and holistic frameworks also incorporate the perspective of sustainable development into the assessment of vulnerability (Birkmann, 2006b).

The fourth school of thought emerged within the context of CCA (see e.g., Füssel and Klein, 2006). Most of these approaches focus closely on the definition of vulnerability used by the IPCC (AR4). Vulnerability in this regard is understood as a function of exposure, sensitivity,[3] and adaptive capacities (Füssel, 2007a,b; McCarthy et al., 2001; IPCC, 2007; O'Brien et al., 2008a,b). These frameworks, however, differ from the understanding of vulnerability in the DRM community in that they take into account the rate and magnitude of climate change. This introduces a critical distinction between the understanding of vulnerability within climate change and the other schools of thought discussed above. The concept of vulnerability here includes external environmental factors of shock or stress. Hence, in this view, the magnitude and frequency of potentially hazardous events is to be included in the calculation of vulnerability to climate change and hence, the vulnerability concept shifts toward a risk definition.

1.3 MULTIDIMENSIONAL AND HOLISTIC PERSPECTIVE: THE MOVE FRAMEWORK

1.3.1 Goals of the Framework

A key goal when developing the MOVE framework was to provide an improved conceptualization of the multifaceted nature of vulnerability, accounting for key causal factors such as exposure, susceptibility, lack of resilience (lack of societal response capacities), as well as for the different thematic dimensions of vulnerability: physical, social, ecological, economic, cultural, and institutional.

3. Interestingly, the term sensitivity means different things to different communities; however, the actual factors used to assess sensitivity of a system in CCA can be closely linked to factors that are used to characterize susceptibility or fragility in the DRM context.

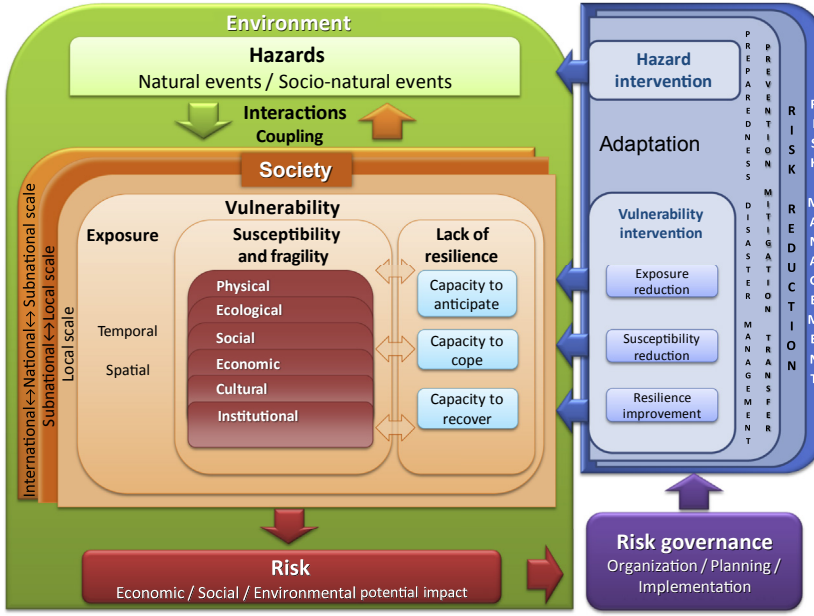

FIGURE 1.1 The MOVE framework. *Own figure, based particularly on concepts of Cardona, 1999a, 2001, p. 65; Turner et al., 2003; Bogardi and Birkmann, 2004; IDEA, 2005; Birkmann, 2006b; Carreño et al., 2007a; see also Birkmann et al., 2013.*

Additionally, the framework incorporates the concept of adaptation into DRM, and therewith explicitly differentiates coping from adaptation.

The MOVE conceptual framework (see Figure 1.1) underlines that hazards are of natural or socio-natural origin while vulnerability in its multifaceted nature is mainly linked to societal conditions and processes.

1.3.2 Key Factors of Vulnerability within the MOVE Framework

At its core, the MOVE framework differentiates key factors of vulnerability and shows the different thematic dimensions of vulnerability. The key factors of vulnerability are defined as follows:

1. Exposure describes the extent to which a unit of assessment falls within the geographical range of a hazard event. Exposure extends to fixed physical attributes of social systems (infrastructure) but also human systems (livelihoods, economies, cultures) that are spatially bound to specific resources and practices that may also be exposed. Exposure is then qualified in terms of spatial and temporal patterns.
2. Susceptibility (or fragility) describes the predisposition of elements at risk (social and ecological) to suffer harm. Although susceptibility and fragility imply subtle differences in various concepts, we mainly use them synonymously

within the *meta*-framework in order to emphasize the core differences between exposure, susceptibility, and lack of resilience. In this context, susceptibility (or fragility) can be calculated and addressed often independent of exposure.

3. Lack of resilience or societal response capacity is determined by limitations in terms of access to and mobilization of the resources of a community or a social-ecological system in responding to an identified hazard. This includes preevent risk reduction, in-time coping, and postevent response measures. Compared to adaptation processes and adaptive capacities, these capacities focus mainly on the ability to maintain the system in light of a hazard event impacting the system or element exposed. In this sense, the capacity to anticipate, the capacity to cope, and the capacity to recover can include significant changes to existing practices around a referent hazard event/scenario but does not include learning based on the potential for future change in hazard and vulnerability contexts. However, the concept of resilience also includes learning and reorganization processes, and therefore is positioned as a subcomponent of the adaptation box. Compared to the key factor "lack of resilience", which refers to existing capacities, the adaptation box also deals with the ability of a community or a system to learn from past disasters and to change existing practices for potential future changes in hazards as well as vulnerability contexts.
4. Hazard is used to describe the potential occurrence of natural, socio-natural, or anthropogenic events that may have physical, social, economic, and environmental impact in a given area and over a period of time. Therefore, hazard is defined by the potentiality of geodynamics or hydro-meteorological processes to cause effects upon exposed elements. In addition, the concept of coupling emphasizes the framework's assertion that any defined hazard is given form and meaning by interaction with social systems, and similarly, social systems are influenced by their actual and perceived hazard context.

1.3.2.1 Multidimensional Vulnerability

In addition to key factors of vulnerability, core thematic dimensions of vulnerability have to be addressed within a holistic assessment process. Key thematic components are explained as follows:

- *Social dimension*: propensity for human well-being to be damaged by disruption to individual (mental and physical health) and collective (health, education services, etc.) social systems and their characteristics (e.g., gender, marginalization of social groups).
- *Economic dimension*: propensity for loss of economic value from damage to physical assets and/or disruption of productive capacity.
- *Physical dimension*: potential for damage to physical assets including built-up areas, infrastructure, and open spaces.
- *Cultural dimension*: potential for damage to intangible values including meanings placed on artifacts, customs, habitual practices, and natural or urban landscapes.

- *Environmental dimension*: potential for damage to all ecological and biophysical systems and their different functions. This includes particular ecosystem functions and environmental services (see e.g., Renaud, 2006) but excludes cultural values that might be attributed.
- *Institutional vulnerability*: potential for damage to governance systems, organizational form and function, as well as guiding formal/legal and informal/customary rules—any of which may be forced to change following weaknesses exposed by disaster and response.

The majority of assets and systems exposed to hazard will exhibit more than one dimension of vulnerability.

1.3.2.2 Risk and Risk Governance

In contrast to vulnerability, risk is defined as the probability of harmful consequences or losses resulting from interactions between hazard and vulnerable conditions. It is the potential for physical, social, economic, environmental, cultural, or institutional consequences or losses, in a given area and over a period of time (see UNISDR, 2004). In addition, risk governance is linked to decisions and actions performed by formal stakeholders such as governments or different governmental institutions and informal stakeholders (individual households) that include tasks on risk reduction, prevention, mitigation, and transfer, and also preparedness and disaster management (see e.g., Renn, 2008).

1.3.2.3 Adaptation

Adaptation and adaptive capacities describe techniques, assets, and strategies applied or available to intervene in vulnerability; i.e., manage exposure, susceptibility, and resilience at any one moment in time. Compared to the concept of coping, adaptation here is understood as a mechanism and response capacity that also aims to change existing institutional and organizational structures and hence does intend to modify the system; while coping is associated with capacities to maintain a system as it is in the face of adverse consequences. In this regard, resilience building and improvement is seen as a component of adaptation. Compared to capacities to cope or to recover (classified as the "lack of resilience"), resilience in the adaptation box refers to learning and reorganization processes in the light of potential future changes and hazards, as well as potential changes in vulnerability. Consequently, the concept of resilience is differentiated into (1) a more reactive part that refers to the lack of resilience, while (2) the ability to learn and to reorganize in anticipation of future changes (proactive actions) are linked to the notion of adaptation. While coping capacities and resilience are primarily linked to capacities that help to maintain the current status of the systems under stress, adaptation as a concept implies actions aimed at making more profound change in socio-ecological relations (see e.g., Pelling, 2010; Birkmann, 2010, 2013).

1.3.3 Theoretical Grounding of the Concept: System Thinking and Nonlinearity

In terms of the underlying theoretical concept, the framework is based on and refers to general systems theory, cybernetics and interlinked systems theory (see e.g., Vester, 2008). It underlines that vulnerability and risk are embedded in processes and therefore have a dynamic nature—they change over time. Although this has been stressed by different authors in the past (see e.g., Keiler et al., 2006; Bründl et al., 2010), many vulnerability and risk assessment approaches in the context of natural hazards and climate change still do not account for capacities to cope and to adapt and hence do not link their thinking to newer approaches in the context of disaster risk reduction and CCA. Compared with the linear understanding of feedback and response processes held by cybernetic theory and the idea that systems can be steered more or less easily, the MOVE framework is based on the understanding that risks also involve complexity and the emergence of different vulnerability as well as response patterns to risks observed. This thinking can build on a legacy of engagement with cybernetics in the geographical tradition of hazards studies (Cardona, 2001, 2010; Hilhorst, 2004; Pelling, 2010). Critics argued that while the cybernetic approach had made progress in providing a framework that recognized social context as a mediating pressure on the environment, it did not have the conceptual tools to analyze these relationships. Deeper social relations of production and power were not included.

Current perspectives on adaptation, vulnerability, and risk to climate change developed from systems thinking within the socio-ecological systems school have made some advances in integrating power dynamics into models of risk (see e.g., Gunderson and Holling, 2002). The policy warning is that social systems will change in time driven either by environmental crisis or preemptive risk management (Handmer and Dovers, 1996). It is possible to insert power into this analysis through the interaction of institutions or structures and agency in cycles of adaptation. The challenge here is to understand under which conditions institutions and decision makers are able to deal with interacting social and ecological crises (Galaz et al., 2011).

1.4 THE APPLICATION: CRITERIA AND INDICATORS

The MOVE framework is first and foremost a thinking tool, however, it also served as an important guiding vision for the development of specific criteria and indicators that allow to assess vulnerability in different cities and regions in Europe and worldwide. Within the application of the framework and the development of concrete assessment tools, the constraints and limits of the framework become evident. However, interestingly, various case studies presented in this volume show that many case studies could apply the framework within the empirical research process or selected components of it.

The case studies dealing with seismic risk in Barcelone (Spain) and the flood vulnerability assessment in the Salzach River Basin as well as the floods in Cologne use various core factors of vulnerability outlined in the MOVE framework within their assessment. In this regard, important indicators for assessing (1) exposure, (2) susceptibility, and (3) response capacities in terms of the lack of resilience (lack of coping or recovery capacities) as well as adaptation processes are shown. Consequently, the framework can be operationalized for specific assessments. More specific vulnerability and risk assessments are conducted within the context of the healthcare system in Florence (Italy) and the heatwave vulnerability and risk management capacities in London (UK). Vulnerability assessments to forest fires and coastal erosion is demonstrated within the case study of Portugal and a vulnerability assessment to mass movements in mountainous environments is show with the case study of South Tyrol.

Overall, the examples show that most of the components of the MOVE framework can be applied as a basis for developing and differentiating indicators and criteria for vulnerability assessment within the broader context of risk management and risk governance. However, the interested reader will also find important differences in the operationalization and further concretization of different vulnerability factors and concepts such as adaptation and coping. These differences could be seen as a cacophony of the concept and term again; however, we view these differences and specific perspectives also as an important part of the contextualization of the general MOVE framework and the concept of vulnerability. That means compared to a standardized natural hazard assessment, for example, in terms of earthquake hazards using the Richter or Moment Magnitude scale, vulnerability about societal conditions and hence has to be translated and operationalized within a specific context. Consequently, some indicators and core factors of vulnerability might need to be interpreted differently or have to include additional information and indicators in order to make sense for the specific spatial, cultural, or socio-economic context. The core message that the MOVE framework provides for DRM and CCA is that even if the exposure of people or infrastructures or ecosystems is similar, the vulnerability of different groups, infrastructures, and ecosystems is most likely to be different, since vulnerability is differential. For example, in the case of the assessment of social vulnerability in Barcelona, low-income groups and low-income urban areas were used as proxies to assess particularly vulnerable groups and areas. The lack of institutional resilience was assessed by using expert interviews and a benchmark index for preparedness and the capacity of different agencies to deal with earthquake-related disasters (rescue teams, fire brigades, etc.) in Barcelona. Hence, the assessment of response capacities requires a more precise understanding of the hazard and specific vulnerabilities that should be considered when evaluating response and preparedness strategies and capacities. Overall, the case studies provide a rich overview of different vulnerability facets and the approach to systematize important information according to the framework outlined before.

1.5 CHALLENGES AND OUTLOOK

Against the background of the diverse approaches and assessment methods used in DRM and CCA, the MOVE framework presented and the further application of it in case study cities or regions (see case study chapters) shows that a common *meta*-approach can be achieved linking different approaches and research communities. In this regard it is also important to note that the MOVE framework and its discussion also informed particularly the new framing of risk management within the Intergovernmental Panel on Climate Change (IPCC). The IPCC Special report on "Managing the Risk of Extreme Events to Advance Climate Change Adaptation" is based on this broader framing of vulnerability and the understanding that extreme events do not necessarily cause extreme impacts. Rather the new framework of the IPCC underscores that next to the physical phenomena (e.g., hazard or extreme weather event), exposure and vulnerability are key in determining whether such extreme events can cause extreme impacts (see IPCC, 2012).

As a heuristic, the MOVE framework is a thinking tool to guide systemic assessment processes and the development of indicators, which for example could be described in specific guiding documents (Vinchon et al., 2011). However, the framework does not provide a specific assessment method (qualitative or quantitative) or a predefined list of indicators. Rather, it outlines key factors and different dimensions of vulnerability that can serve as a basis for a systematic operationalization of vulnerability (see the following chapters). The framework stresses the fact that many interactions that shape vulnerability are dynamic (change over time) and characterized by nonlinearity and place-specific factors. Thus, the application of the framework has to consider the place-specific characteristics that influence vulnerability and its components as well as the coupling processes between social and environmental systems. In addition, this framework considers different scales: not only recognizing the fact that certain characteristics are typical or only valid at a certain scales (e.g., community versus global assessment) but also reflecting the fact that specific scales (spatial and temporal scales) correspond with different needs of stakeholders and institutions operating at different times and spatial ranges. The specific translation of the framework into concrete measures also depends on the research object or subject (social group, physical buildings, socio-ecological systems) and the hazard context. An important benefit of the framework can be seen in the ability to straddle multiple approaches and epistemologies in natural and social sciences and DRM. Instead of focusing solely on the deficiencies of a community or incapacities of different social groups or social-ecological systems, the concept and its application shows that vulnerable groups or systems have also developed capacities that help them to survive or deal with changing environmental conditions.

Lastly, the framework is easy to understand for different disciplines and therefore enables and promotes the communication process between different communities, particularly between the DRM and CCA community. In this context, the framework also has a strong relevance for policy makers that aim to

base their decisions on a comprehensive and integrative approach of vulnerability and risk identification. For example, the EU Flood Directive on Assessment and Management of Flood Risks (2007/60/EC) and the subsequent EU Flood Directive Implementation Strategy lack to address vulnerability in a comprehensive and integrative approach. In this regard, the framework could be used to inform agencies responsible for carrying out flood risk maps in the context of the directive, in terms of providing them with a broader overview of the various dimensions and key factors that should be considered within a holistic approach.

However, challenges remain with regard to the implementation of the framework and its key components in highly diverse hazards and cultural context situations. In particular, the intangible factors that determine institutional or cultural vulnerability are difficult to capture and to assess. However, the selected examples shown in the table provide an illustration on how one can capture these rather intangible aspects within such assessments. Hence, it is proven that these facets of vulnerability can be translated into assessable criteria and indicators.

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